

# ANALYSIS OF SCHEDULING TECHNIQUES FOR IEEE 802.16 BASED WIRELESS NETWORKS

By

Rajagopal Iyengar

A Thesis Submitted to the Graduate  
Faculty of Rensselaer Polytechnic Institute  
in Partial Fulfillment of the  
Requirements for the Degree of  
DOCTOR OF PHILOSOPHY  
Major Subject: Electrical Engineering

Approved by the  
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Rensselaer Polytechnic Institute  
Troy, New York

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The original of the complete thesis is on file  
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## ABSTRACT

Broadband wireless Internet access is rapidly gaining popularity as an alternative to traditional wireline access techniques. A new generation of wireless devices and applications are driving demand and creating a market for these services. It is possible that such networks will soon be a ubiquitous feature in the network connectivity space. The emerging IEEE 802.16 body of standards show promise in terms of providing a flexible and comprehensive framework to achieve these objectives. One of the most important components in such a wireless system which serves a number of users under a number of constraints like different QoS metrics of the users (such as delay, rate etc) and system objectives like spectral efficiency and throughput maximization is the scheduling algorithm. For 802.16 based wireless networks, the draft while specifying a framework for implementation, does not specify the exact scheduler to be used. Hence, there is a need to propose and analyze the performance of scheduling techniques for 802.16 (Wimax). Further, there is little or no literature specific to this space. We start by presenting a queuing analysis to calculate the average delay when 802.16 framing is used with simple scheduling techniques. Next we present a delay analysis of a multichannel 802.16 system, when distributed random access is used by clients to contend for resources. Using a few simplifications to make the analysis tractable, we obtain an accurate characterization of the average delay experienced by packets in such multichannel, random access systems. We extend results in Fair Queuing for wireless networks to 802.16 specific results. Next, we present hardness results and LP based formulations for scheduling in 802.16 systems which use OFDMA at the PHY layer. We show that the general scheduling problem is NP-Complete and present some efficient algorithms and heuristics to solve these problems. Based on the specific characteristics of Wimax systems, we propose simple and intuitive Linear Programming formulations of scheduling techniques for schedulers which optimize user objectives as well as system objectives. Finally, we discuss some open problems resulting from the current work as well as some interesting future directions that this thesis has thrown open.